DPR Profile Classification Module

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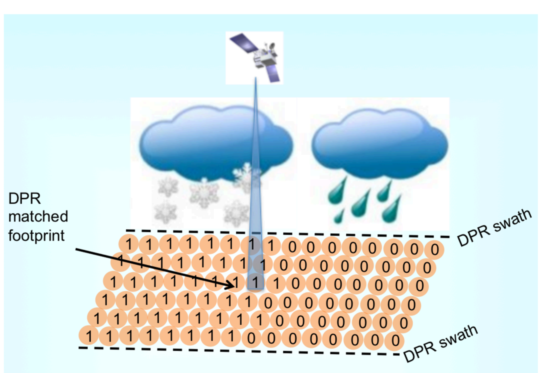
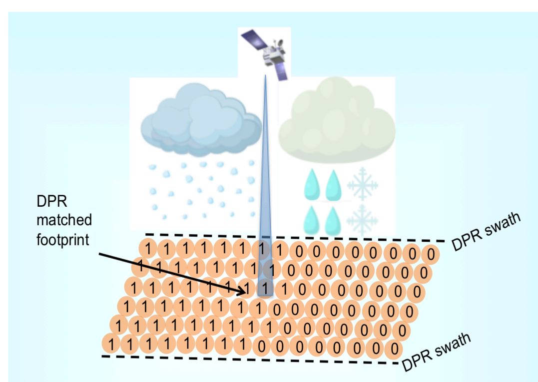
PMM Science Meeting, Nov 4-8, 2019,Indianapolis

Abstract

As part of the DPR algorithm development group, this poster presents the updates for the profile classification module in DPR level 2 algorithm. Global analysis is performed on the product of "flagsurfaceSnowfall". The result is compared with the estimates from CloudSat also.

New function of graupel and hail identification has been implemented in the DPR level 2 algorithm. Similar to the surface snowfall identification algorithm, precipitation type index (PTI) is applied to identify GH profiles. Validation with 13 NEXRAD radars have been performed within the United States and show promising results. The result from the global scale analysis is cross validated with estimates from passive instruments.

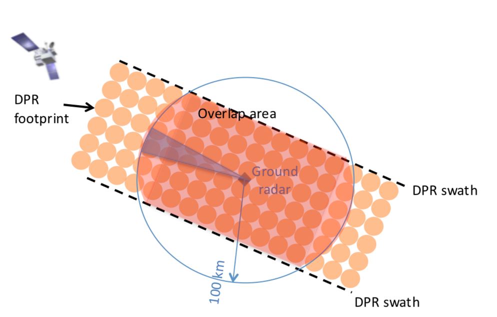




- In the current DPR level-2 algorithm, the "flagSurfaceSnowfall" is Boolean product detects whether surface has snowfall or not (Le and Chandrasekar, 2019).
- A precipitation type index (PTI) with certain threshold is used to identify surface snowfall.
- Same precipitation type index but with different threshold is used to identify graupel and hail (Le and Chandrasekar, 2018).
- The product of "flagGraupelHail" (or "GH flag") is being implemented in the Experimental structure. Its format is similar to flagSurfaceSnowfall. The output is either 1 or 0. 1 means "graupel and hail exists" and 0 means "graupel and hail not exists". This is for along the vertical profile, not for surface.

$$\text{Precipitation type index (PTI)} = \frac{DFR_m \text{ slope with respect to height}}{\text{Maximum of } Zm_{Ku} \times \text{Storm top height}}$$

Surface Snowfall Identification



A cartoon illustration to depict the approach performing quantitative validation between surface snowfall identification algorithm and ground radar hydrometeor types. In the Table, ground radars include NEXRAD, CSU-CHILL and NPOL.

RADAR	Date	Surface Type	GPM DPR orbit #
KDVN	2015-11-21	Flat Land	9828
KEAX	2015-01-31	Flat Land	5263
KIWX	2015-03-23	Lake	6052
KOKX	2015-01-09	Coastline	4914
NPOL	2015-11-14	Coastline	9722
NPOL	2015-12-03	Coastline	10019
KAPX	2016-02-25	Lake	11319
KAKQ	2016-02-05	Coastline	11011
KARX	2016-03-24	Flat Land	11755
CSU-CHILL	2016-04-16	Mountain	12119
KGRR	2017-11-18	Lake	21160
KOTX	2017-12-20	Flat Land	21648
KCLE	2017-02-04	Lake	21554
KDOX	2018-01-04	Coastline	21882

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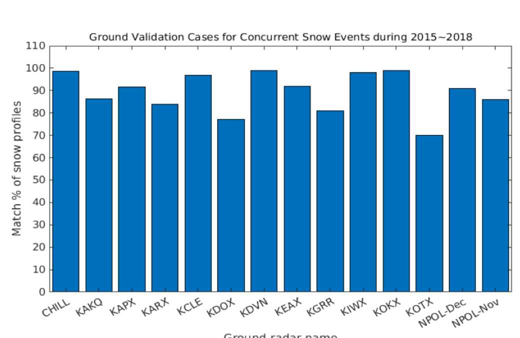
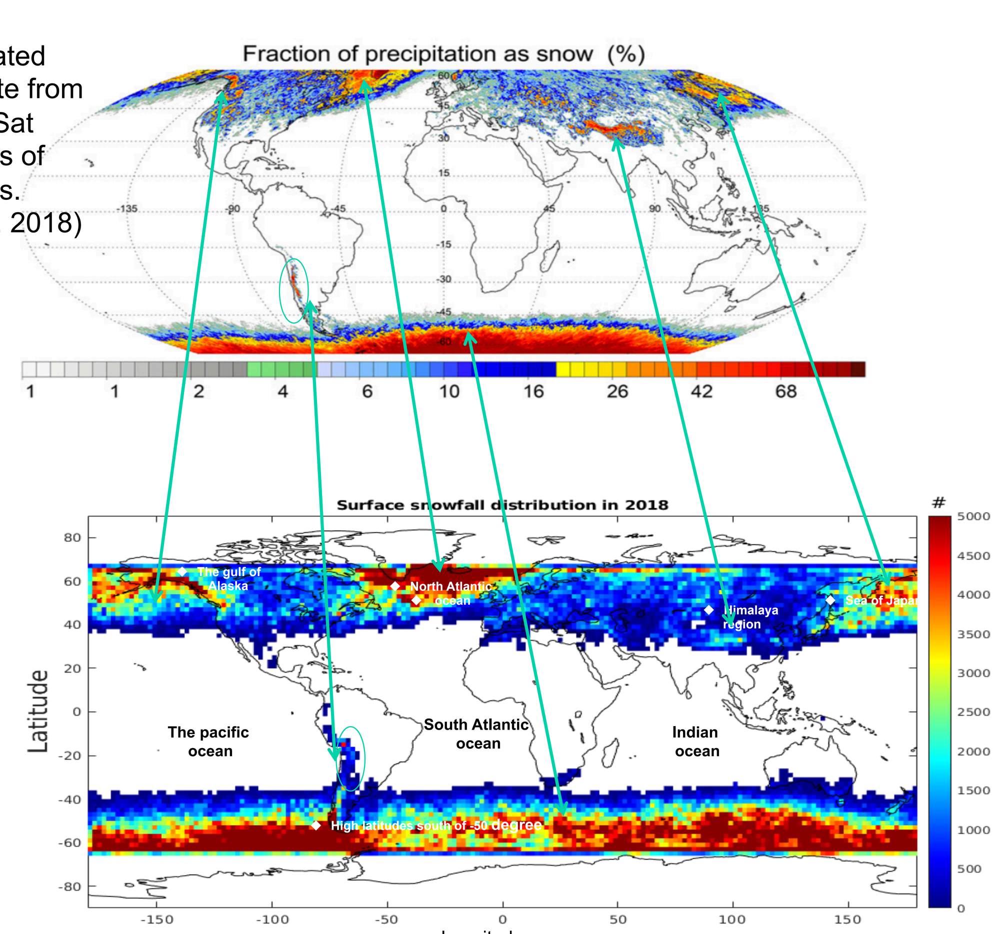


Surface type	Flat Land	Coastline	Lake	Mountain
Averaged Match %	86.3%	87.9%	91.9%	98.5%

$$\text{Match \%} = \frac{\text{\# of footprints agree}}{\text{total \# of footprints with precipitation}}$$

Global Scale Analysis

The plot is calculated based on snowrate from KuPR and CloudSat radar from 3 Years of GPM observations. (Adhikari, A. et al. 2018)

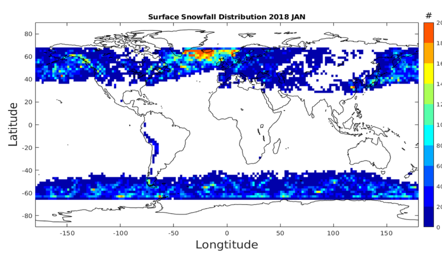


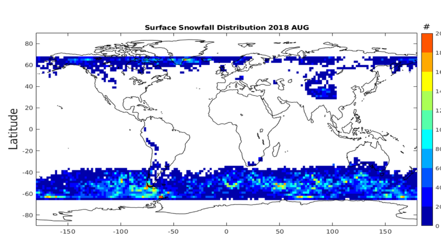
Global distribution of "flagSurfaceSnowfall" count mapping into 2x2 degree Lat/Lon for year of 2018.

- Consistent with Adhikari et al. 2018 and Liu (2008), in the Northern Hemisphere, the higher count number of precipitation as snow are found over specific geographical locations, such as

the Gulf of Alaska,
North Atlantic Ocean,
Himalaya region,
the Sea of Japan.

- In the Southern Hemisphere, the surface snowfall increases toward high latitudes, and most of the snow falls at the latitudes south of -50 degree.



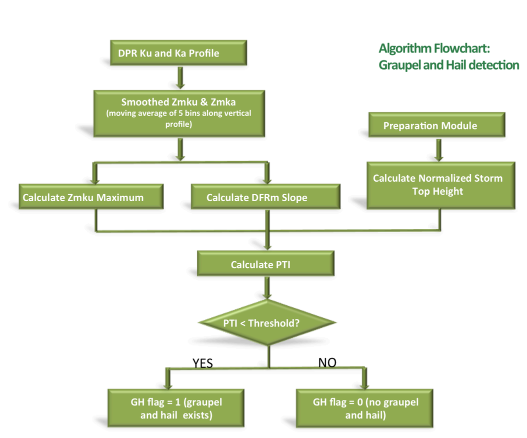


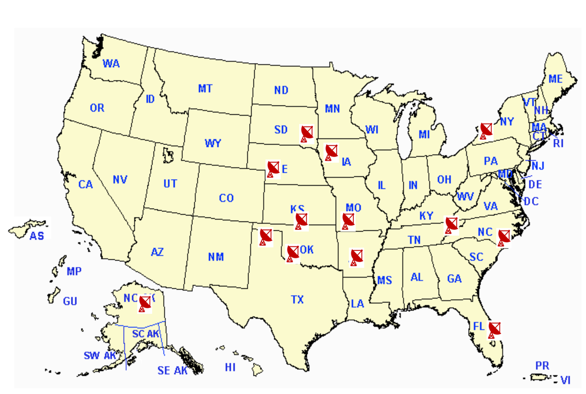
Global distribution of surface snowfall Count in 2018

JAN VS AUG

- In January, north hemisphere is winter time. Much more surface snowfall is detected than in the August.
- In August, south hemisphere is winter. Snow detected region is wider from -36 to the limit of GPM than that of shown in the January plot.

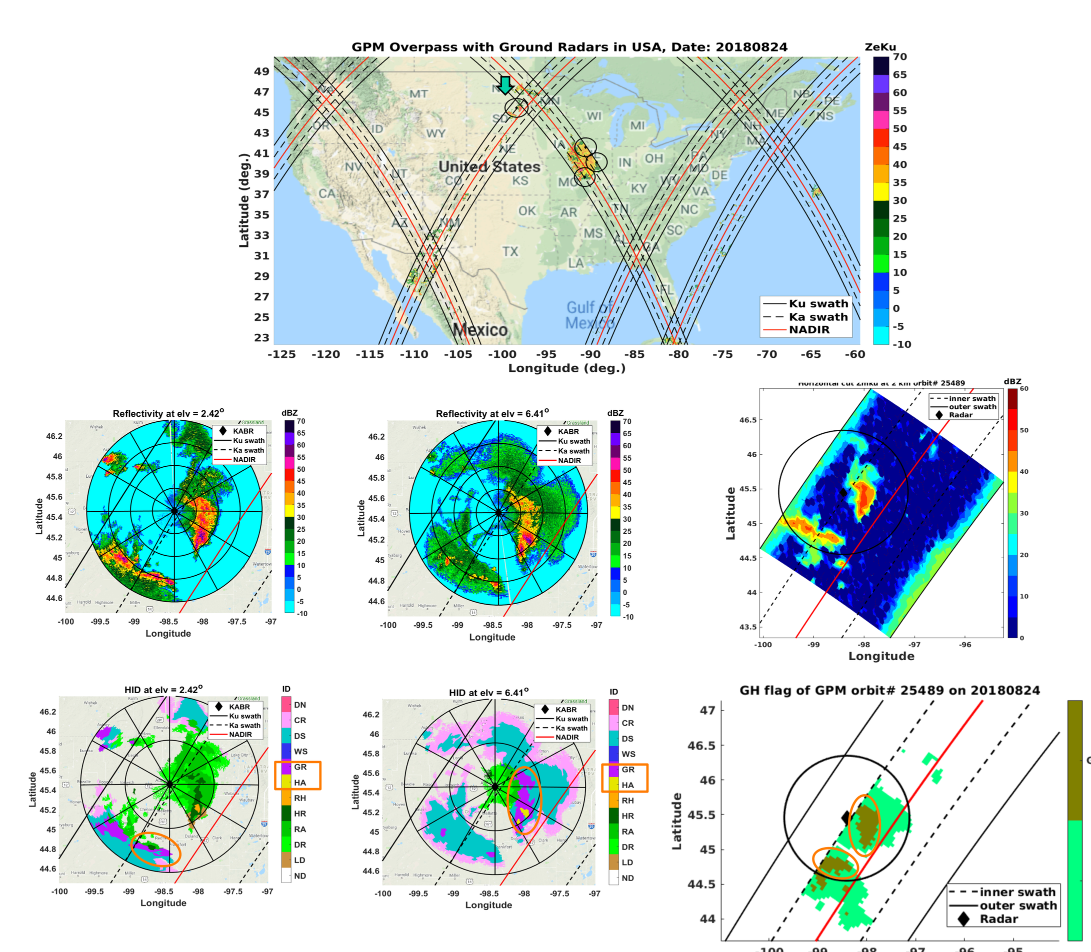
Graupel and Hail Identification



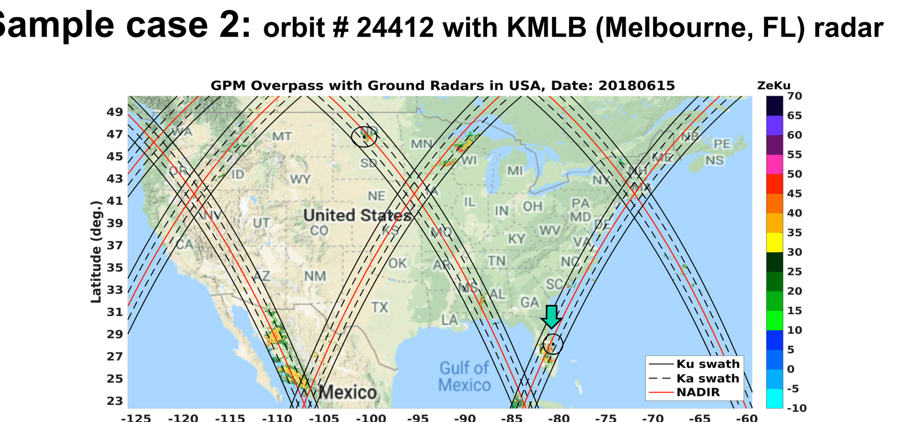


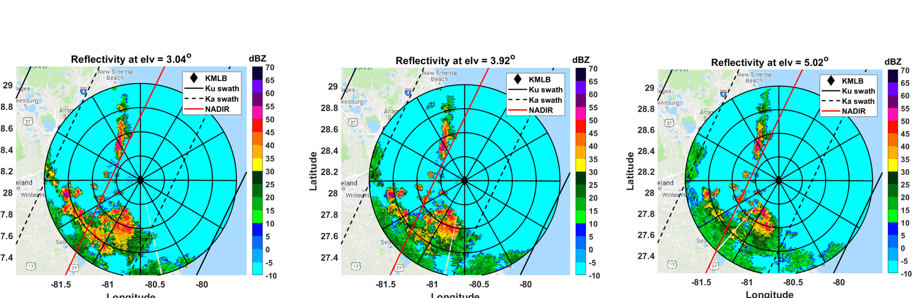
- Algorithm flow chart is shown here. Algorithm details are found in Minda and Chandrasekar, 2018.
- 13 intense weather events are chosen between 2018 May to 2018 September over United States, including case at high latitude in Alaska.
- These cases are simultaneously captured by GPM-DPR and WSR-88D radars. Hydrometeor identification algorithm is performed on WSR-88D radars first. Chosen cases are all detected with Graupel or Hail.
- Graupel and Hail identification algorithm for GPM is applied and the result of "flagGraupelHail" is compared with ground radar results.

Sample case 1: orbit # 25489 with KABR (Aberdeen, SD) radar

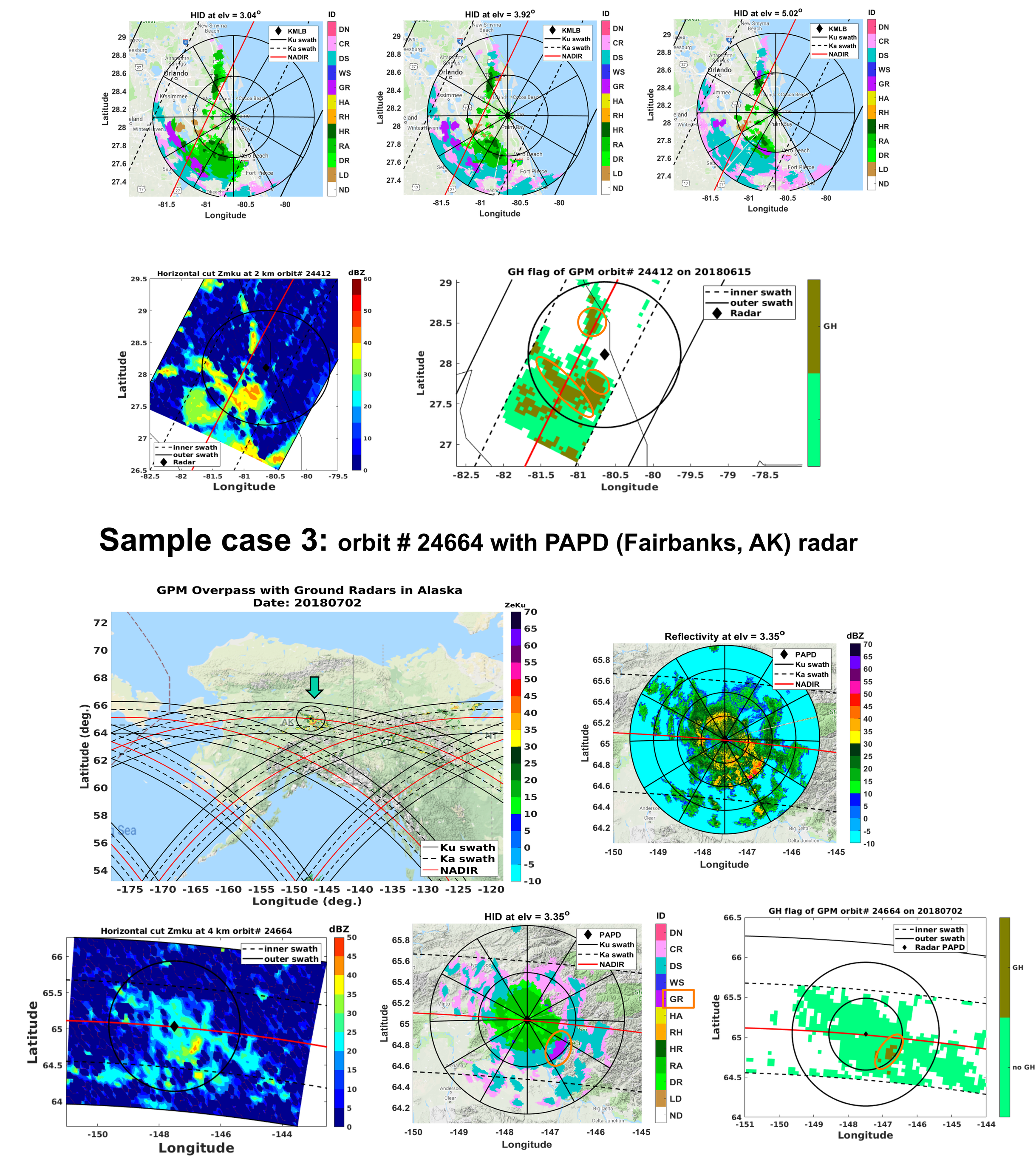


Sample case 2: orbit # 24412 with KMLB (Melbourne, FL) radar

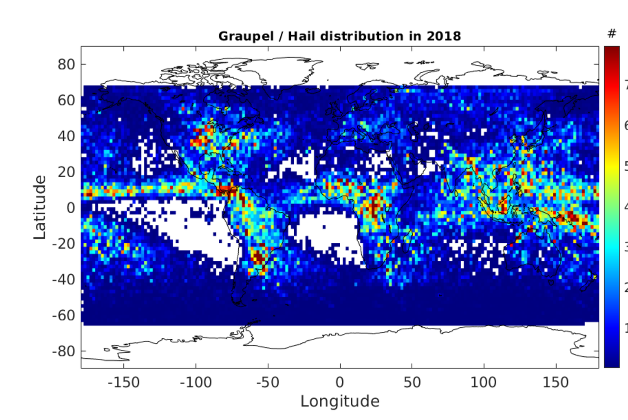




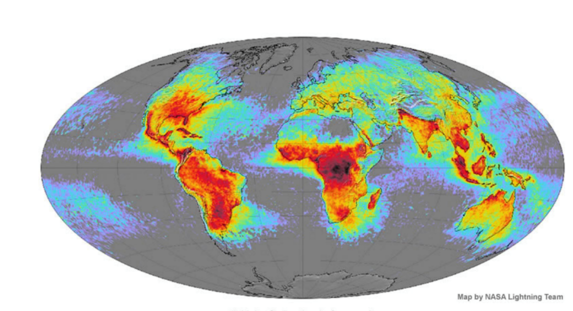
Sample case 3: orbit # 24664 with PAPD (Fairbanks, AK) radar



Global Scale Analysis



Global distribution of "flagGraupelHail" count mapping to the 2° x 2° Lat / Lon box for year 2018.



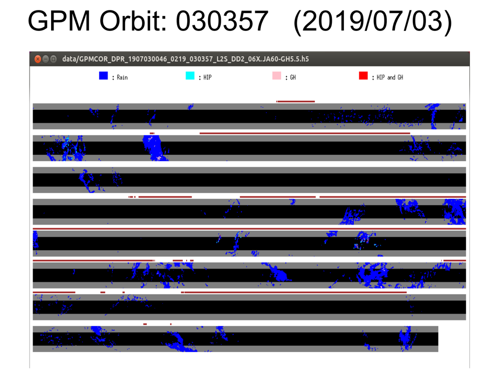
World Lightning Map: The map above shows the average yearly counts of lightning flashes per square kilometer based on data collected by NASA's Lightning Imaging Sensor on the Tropical Rainfall Measuring Mission satellite between 1995 and 2002. Places where less than one flash occurred (on average) each year are gray or light purple. The places with the largest number of lightning strikes are deep red, grading to black. (This Map is made by NASA Lighting Team).

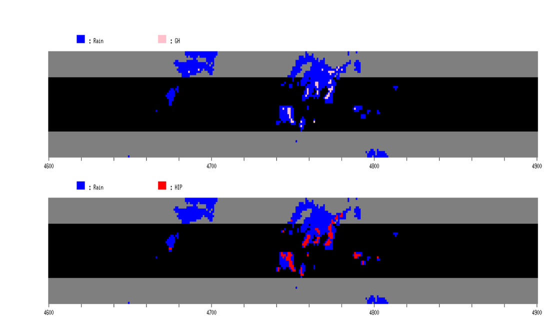
- Active lightning regions are believed to be associated with the existence of graupel at high altitudes.
- Good association can be found at circled areas between these two maps.
- More lightning occurs over land than over the ocean.
- More lightning occurs near the equator than at the poles.
- Regions of Intense Lightning Activity

The Democratic Republic of the Congo
Northwestern South America
The Himalayan Forelands
Central Florida
The Pampas of Argentina
Indonesia

Initial Implementation

GPM Orbit: 030357 (2019/07/03)





Summary

Updates on the profile classification module are presented. The surface snowfall identification algorithm and graupel & Hail identification algorithm are discussed in details. Global analysis shown generally consistent with estimates from lightening sensor. Algorithm validation and improvements for the full scan will be done in the near future.

Reference

M. Le and V. Chandrasekar, Graupel and Hail Detection using GPM Dual-frequency Precipitation Radar Observation, AGU fall meeting, 2018, Washington DC.

Le, M. and V. Chandrasekar, 2019: Ground Validation of Surface Snowfall Algorithm in GPM Dual-Frequency Precipitation Radar. J. Atmos. Oceanic Technol., 36, 607–619.

Adhikari, A., C. Liu, and M.S. Kulie, 2018: Global Distribution of Snow Precipitation Features and Their Properties from 3 Years of GPM Observations. J. Climate, 31, 3731–3754.

Liu, G., 2008: Deriving snow cloud characteristics from CloudSat observations. *J. Geophys. Res.*, 113.

This work is supported by the GPM PMM program.